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I. AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

- 1           1.       (Currently amended) A triple-junction solar cell comprising:  
2           a first cell layer comprising a germanium (Ge) substrate having a first and second  
3                   diffusion regions doped with n-type dopants, wherein the second diffusion  
4                   region diffuses deeper into the Ge substrate than the first diffusion region,  
5                   wherein ~~the n-type dopants in the first diffusion region~~ has a higher  
6                   concentration of includes phosphorus (P) atoms than arsenic (As) atoms and  
7                   ~~having the highest dopant concentration and the n-type dopants in the second~~  
8                   diffusion region has a higher includes ~~arsenic (As) atoms having the highest~~  
9                   ~~dopant concentration of As atoms than P atoms;~~  
10          a nucleation layer disposed over the Ge substrate of the first cell layer;  
11          a second cell layer comprising one of gallium arsenide (GaAs) and indium gallium  
12                  arsenide (InGaAs) disposed over the nucleation layer; and  
13          a third cell layer comprising indium gallium phosphide (InGaP) disposed over the  
14                  second cell layer.
- 1           2. (Original) The triple-junction solar cell as recited in Claim 1 wherein the nucleation  
2                  layer comprises a material having a lattice parameter substantially equal to the  
3                  lattice parameter of the germanium substrate.

1 3. (Original) The triple-junction solar cell as recited in Claim 1 wherein the nucleation  
2 layer comprises InGaP.

1 4. (Original) The triple-junction solar cell as recited in Claim 1 wherein the nucleation  
2 layer has a thickness substantially equal to 350 Å or less.

1 5. (Previously presented) The triple-junction solar cell as recited in Claim 1, wherein  
2 the triple-junction solar cell is capable of absorbing radiation ranging from  
3 approximately ultraviolet (UV) radiation to radiation having a wavelength of  
4 approximately 1800 nm.

1 Claims 6-7. (Cancelled).

1 8. (Original) The triple-junction solar cell as recited in Claim 1 wherein the junction  
2 depth in the first cell layer is substantially between 0.3 μm and 0.7 μm.

1 9. (Original) The triple-junction solar cell as recited in Claim 1 wherein the first cell  
2 layer comprises a two-step diffusion profile capable of optimizing current and  
3 voltage generated therefrom.

1 10. (Original) The triple-junction solar cell as recited in Claim 1 having 1 sun AM0  
2 efficiencies in excess of 26%.

1 11. (Currently amended) A triple-junction solar cell comprising:  
2 a dual-junction structure comprising a first junction and a second junction;  
3 a third junction having a p-type substrate, wherein the third junction is doped with  
4 arsenic (As) and phosphorus (P), wherein the p-type substrate includes [[a]] first  
5 and second diffusion sublayers, wherein at least a portion of the second  
6 diffusion sublayer is deeper into the p-type substrate than the first diffusion  
7 sublayer, wherein [[the]] P atoms have higher concentration compared to As  
8 atoms in the first diffusion sublayer and [[the]] As atoms have a higher  
9 concentration compared to P atoms in the second diffusion sublayer; and  
10 a nucleation layer disposed between the dual-junction structure and the third junction  
11 and comprising a material that shares a substantially similar lattice parameter  
12 with the p-type substrate of the third junction, wherein the nucleation layer  
13 serves to control the diffusion depth of the third junction.

1 12. (Previously presented) The triple-junction solar cell as recited in Claim 11 wherein  
2 the p-type substrate of the third junction is germanium (Ge) and the nucleation  
3 layer comprises indium gallium phosphide (InGaP).

1 13. (Original) The triple-junction solar cell as recited in Claim 11 wherein the  
2 nucleation layer has a thickness substantially equal to 350 Å or less.

1 Claims 14-15. (Cancelled).

1 16. (Original) The triple-junction solar cell as recited in Claim 11 wherein the junction  
2 depth of the third junction is substantially between 0.3  $\mu\text{m}$  and 0.7  $\mu\text{m}$ .

1 17. (Original) The triple-junction solar cell as recited in Claim 11 wherein the third  
2 junction comprises a two-step diffusion profile capable of optimizing current  
3 and voltage generated from the third junction.

1 18. (Original) The triple-junction solar cell as recited in Claim 11 having 1 sun AM0  
2 efficiencies in excess of 26%.

1 19. (Original) The triple-junction solar cell as recited in Claim 11 capable of absorbing  
2 radiation ranging from approximately ultraviolet (UV) radiation to radiation  
3 having a wavelength of approximately 1800 nm.

1 20. (Currently amended) A method for controlling the diffusion of a dopant into a  
2 substrate during a subsequent device process during the fabrication of a multi-  
3 layer semiconductor structure, the method comprising:

- 4 (a) disposing a nucleation layer over the substrate;  
5 (b) performing the subsequent device process to form an overlying device layer  
6 containing the dopant, wherein the dopant[[s]] includes phosphorus (P) and  
7 arsenic (As), wherein the nucleation layer serves as a diffusion barrier to the  
8 dopant in the overlying device layer such that diffusion of the dopant into the  
9 substrate is limited by increasing the thickness of the nucleation layer, wherein

10           the performing the subsequent device process further includes diffusing P atoms  
11           to a shallow diffusion region and diffusing As atoms to a deep diffusion region  
12           of the substrate.

1           21. (Original) The method as recited in Claim 20 wherein the nucleation layer  
2           comprises a material that shares an identical lattice parameter with the substrate.

1           22. (Original) The method as recited in Claim 20 wherein the substrate is germanium  
2           (Ge) and the nucleation layer comprises InGaP.

1           23. (Original) The method as recited in Claim 20 wherein the nucleation layer has a  
2           thickness substantially equal to 350 Å or less.

1           Claims 24-25. (Cancelled).

1           26. (Previously presented) The method as recited in Claim 20 wherein a two-step  
2           diffusion profile is achieved in an n-p junction formed in the substrate.

1           27. (Original) The method as recited in Claim 20 wherein the subsequent device  
2           process includes metal organic chemical vapor deposition (MOCVD).

1           28. (Original) The method as recited in Claim 20 wherein the nucleation layer also  
2           serves as a source of the dopant for forming an n-p junction in the substrate.

1 29. (Original) The method as recited in Claim 20 wherein diffusion of the dopant into  
2 the substrate primarily involves solid state diffusion.

1 30. (Original) The method as recited in Claim 29 wherein diffusion of the dopant into  
2 the substrate also involves gas phase diffusion during oxide desorption.

1 31. (Currently amended) A method for fabricating a multi-layer semiconductor  
2 structure, the method comprising:

- 3 (a) preparing a germanium (Ge) substrate layer for doping by a dopant, wherein the  
4 dopant includes phosphorus (P) atoms and arsenic (As) atoms;  
5 (b) disposing a nucleation layer over the germanium substrate layer;  
6 (c) disposing a middle layer comprising the As atoms over the nucleation layer,  
7 wherein the disposing a nucleation layer further includes controlling diffusion of  
8 the P atoms into a first diffusion sublayer and diffusion of the As atoms into a  
9 second diffusion sublayer, wherein the first diffusion sublayer is substantially  
10 adjacent to the nucleation layer and the second diffusion sublayer is adjacent to  
11 the first diffusion sublayer; and  
12 (d) disposing a top layer comprising indium gallium phosphide (InGaP) over the  
13 second tunnel junction, wherein the nucleation layer serves as a diffusion barrier  
14 such that diffusion of the dopant into the germanium substrate can be limited by  
15 increasing the thickness of the nucleation layer.

1 32. (Original) The method as recited in Claim 31 wherein the nucleation layer  
2 comprises a material having a lattice parameter substantially equal to the lattice  
3 parameter of the germanium substrate.

1 33. (Original) The method as recited in Claim 31 wherein the nucleation layer  
2 comprises InGaP.

1 34. (Original) The method as recited in Claim 31 wherein the nucleation layer has a  
2 thickness substantially equal to 350 Å or less upon completion of said step (b).

1 Claims 35-36. (Cancelled).

1 37. (Previously presented) The method as recited in Claim 31 wherein a junction  
2 depth in the germanium substrate layer is substantially between 0.3 μm and 0.7  
3 μm upon completion of said steps (a) through (d).

1 38. (Currently amended) A multi-junction solar cell comprising:  
2 a p-type germanium (Ge) substrate having a first surface, wherein the p-type Ge  
3 substrate further includes ~~a diffusion portion having~~ a first diffusion sublayer  
4 situated adjacent to the first surface of the p-type Ge substrate and a second  
5 diffusion sublayer situated adjacent to the first diffusion sublayer;  
6 an indium gallium arsenide (InGaAs) nucleation layer disposed over the first surface of



7 the p-type Ge substrate, wherein the InGaAs nucleation layer provides n-type  
8 phosphorus (P) atoms to the first diffusion sublayer, wherein the first diffusion  
9 sublayer has a higher concentration of P atoms than arsenic (As) atoms; and  
10 a Gallium Arsenide (GaAs) buffer layer ~~including arsenic (As) atoms~~ disposed over the  
11 InGaAs nucleation layer, wherein the GaAs buffer layer provides n-type As  
12 atoms to the second diffusion sublayer in response to the thickness of the  
13 InGaAs nucleation layer.

1 39. (Original) The multi-junction solar cell of claim 38, further comprising a  
2 second surface situated at the bottom of the multi-junction solar cell.

1 40. – 42. (Canceled).

1 43. (Currently amended) The multi-junction solar cell of claim 38[[42]], wherein  
2 ~~the As atoms in the second diffusion sublayer has a higher~~ the highest dopant  
3 concentration of As atoms than P atoms.

1 44. (Currently amended) A multi-junction solar cell comprising:  
2 a p-type germanium (Ge) substrate having a first surface, wherein the p-type Ge  
3 substrate further includes a diffusion portion having a first diffusion region  
4 situated adjacent to the first surface of the p-type Ge substrate and a second  
5 diffusion region, which includes a part of all of the first diffusion region,  
6 wherein the second diffusion region diffuses deeper into the Ge substrate than

7           the first diffusion region;  
8           a phosphorus (P) containing nucleation layer disposed over the first surface of the p-  
9           type Ge substrate, wherein the P containing nucleation layer provides n-type  
10          ~~phosphorus (P)~~ P atoms to the first diffusion region; and  
11          an arsenic (As) containing buffer layer ~~including arsenic (As) atoms~~ disposed over the P  
12          containing nucleation layer, wherein the As containing buffer layer [[of GaAs]]  
13          provides n-type As atoms to the second diffusion region in response to the  
14          thickness of the P containing nucleation layer, wherein the second diffusion  
15          region has a higher concentration of As atoms than P atoms.

1           45.   (Original) The multi-junction solar cell of claim 44, further comprising a  
2           second surface situated at the bottom of the multi-junction solar cell.

1           46.   (Currently amended) The multi-junction solar cell of claim 44, wherein the first  
2           diffusion region ~~includes the P atoms and As atoms; wherein the P atoms in the~~  
3           ~~first diffusion region~~ has a higher ~~the highest dopant concentration of P atoms~~  
4           than As atoms.

1           47. – 48. (Canceled).

1           49.   (Currently amended) A multi-junction solar cell comprising:  
2           a germanium (Ge) substrate having ~~a first surface, wherein the substrate further includes~~  
3           ~~a diffusion portion having~~ a first diffusion region situated ~~adjacent to the first~~

4 ~~surface of the substrate and a second diffusion region, which includes a part of~~  
5 ~~all of the first diffusion region,~~ wherein the second diffusion region diffuses  
6 deeper into the Ge substrate than the first diffusion region;  
7 a phosphide nucleation layer disposed over the first surface of the substrate, wherein the  
8 phosphide nucleation layer provides diffusion dopants of phosphorus (P) atoms  
9 to the first diffusion region; and  
10 an arsenide layer ~~having arsenic (As) atoms~~ disposed over the phosphide nucleation  
11 layer, wherein the arsenide layer provides diffusion dopants of arsenic (As)  
12 [[As]] atoms into the second diffusion region in response to the thickness of the  
13 phosphide nucleation layer, wherein the first diffusion region has a higher  
14 concentration of P atoms than As atoms.

1 50. (Original) The multi-junction solar cell of claim 49, further comprising a  
2 second surface situated at the bottom of the multi-junction solar cell.

1 51. (Canceled).

1 52. (Currently amended) The multi-junction solar cell of claim 49, wherein the  
2 second diffusion region ~~includes the P atoms and As atoms,~~ wherein the As  
3 ~~atoms in the second diffusion region~~ has a higher ~~the highest~~ dopant  
4 concentration of As atoms than P atoms.

1 53. (Canceled).